ENCLOSURE 1

ICESAT-2

MISSION OBJECTIVES

Enclosure 1

ICESAT-2 Mission Objectives

Mission Objective:

ICESat-2 is a follow-on mission to continue the measurements taken by ICESat and is being developed in response to the Decadal Survey (2006) which documented the continuation of the ICESat measurements as a top priority. ICESat-2 is being targeted for launch in 2014.

The observatory will be launched into a near polar Low Earth Orbit (LEO) at an altitude of 600 km with an inclination of 94 degrees and a 91 day repeat. ICESat-2 will repeat the ICESAT ground-track.

The ICESat-2 observatory is comprised of one instrument, an improved laser altimeter called ATLAS (Advanced Topographic Laser Altimeter System). ATLAS is a laser altimeter designed to measure ice-sheet topography and associated temporal changes, as well as cloud/atmospheric properties and land surface topography. In addition, ATLAS includes an advanced Laser Reference System (LRS). The LRS supports the altimeter measurement by using a star tracker for precision attitude determination.

Science Summary:

The science objectives of ICESat-2 are:

- Determine polar ice sheet mass balance; understand controlling mechanisms; examine how ice sheets will impact global sea level and ocean circulation in a changing climate.

- Measure sea-ice thickness to understand ice/ocean/atmosphere exchanges of energy, mass and moisture.

- Vegetation cover and global biomass.

Mission/Instrument Summary:

Several mission concepts are under investigation at this time reflecting a range of science requirement and budget trade-offs.

Mission Concept 1 is a single beam profiler with a three-year mission duration. The instrument concept is as follows:

Single-beam Altimeter with LRS

- 4 lasers, one laser on at a time, 50 Hz rep rate, 50 mJ, 70 m beam footprint with 140 m spacing
- Surface range precision of 1-2 cm
- Ice footprint location knowledge to 4.5 m on ground using Laser Reference System (LRS and gyro)

Mission Concept 2 is a single beam profiler mission as described above, however additional redundancy is provided for a five-year mission duration.

Mission Concept 3 is a single-beam profile mission with advanced instrument technology to provide increased capabilities for determining ice elevation changes. This option provides for a five-year mission duration.

Ground Network:

The ground system will capture science and housekeeping data twice per day using X-band and S-band at the NASA Ground Network (GN). The ATLAS instrument and spacecraft engineering data is recorded and stored onboard the observatory for transmission to the GN in Alaska, Norway and Wallops. ICESat-2 transmits data to the PGS via X-band and S-band links. Each of the two contacts will be on average 10 minutes per pass. Real-time spacecraft and instrument housekeeping data shall be downlinked during each pass via S-band.

For the Mission Concept 3, the number of contacts per day will increase to 4-5 to accommodate larger data volumes.

Operations: ICESat-2 routine flight operations are compatible with an 8 hours/day, 5-days/week staffing schedule and uses mainly COTS software**.**

Mission Summary

Mission Lifetime: 3 years requirement with 5 year consumables for Mission Concept 1; 5 year operational requirement with 7 year consumables for Mission Concepts 2 and 3.

Instrument Accommodation Summary:

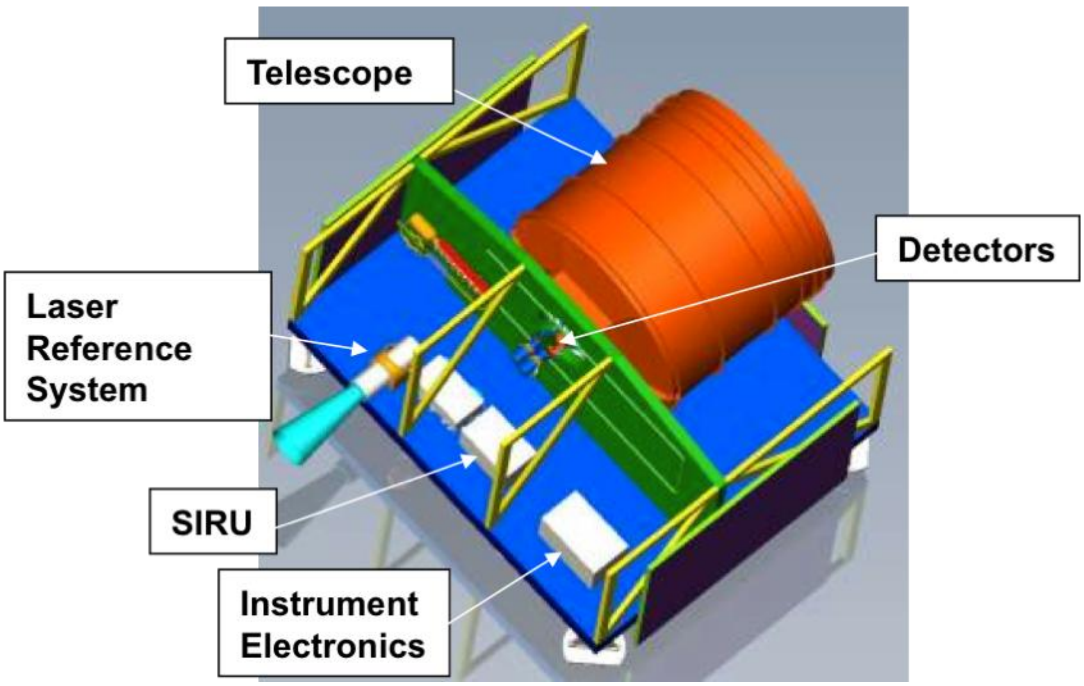

Figure 1-1 ATLAS Conceptual Diagram for Mission Concept 1

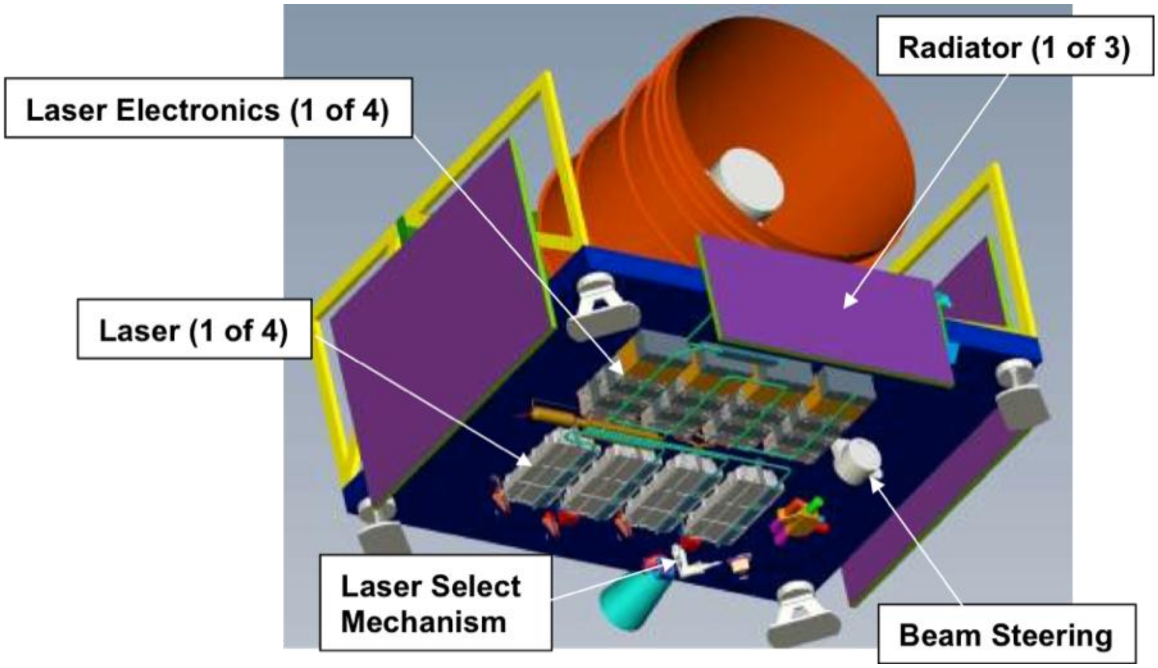

Figure 1-2 ATLAS Conceptual Diagram for Mission Concept 1

	Mission Concept 1	Mission Concept 2	Mission Concept 3
Description	Primary-Beam (3 yr mission)	Primary-Beam (5 yr mission)	Primary Beam plus advanced technology (5 yr mission)
Mass	442kg	500kg	565kg
Power	498W EOL	498W EOL	790W EOL
Peak Data Rate	0.733 Mbps	0.733 Mbps	4.733 Mbps
Science Data Volume	55 Gbit/day	55 Gbit/day	<315 Gbit/day
Command Interface	CCSDS Packets Over Spacewire	CCSDS Packets Over Spacewire	CCSDS Packets Over Spacewire
Data Interface (HK Telemetry	CCSDS Packets Over Spacewire	CCSDS Packets Over Spacewire	CCSDS Packets Over Spacewire

and Science Data			
Power Interface	28V±5V	28V±5V	28V±5V
Instrument Volume (Dimensions are in inches)	61.5 wide X 90.7 long X 55.8 high	82.5 wide X 90.7 long X 55.8 high	82.5 wide X 90.7 long X 55.8 high
Instrument Mechanical mounting	Kinematic or semi-kinematic mount	Kinematic or semi-kinematic mount	Kinematic or semi-kinematic mount
Instrument FOV	FOV is 90 Degrees to mounting interface. Requires clear zenith view	FOV is 90 Degrees to mounting interface. Requires clear zenith view	FOV is 90 Degrees to mounting interface. Requires clear zenith view
ACS	IRU needs to be mounted on optical bench for science reasons. IRU & GPS data needs to be delivered to science team.	IRU needs to be mounted on optical bench for science reasons. IRU & GPS data needs to be delivered to science team.	IRU needs to be mounted on optical bench for science reasons. IRU & GPS data needs to be delivered to science team.
Thermal	Clear FOV for radiators Instrument to be thermally isolated from bus Heater circuits	Clear FOV for radiators Instrument to be thermally isolated from bus Heater circuits	Clear FOV for radiators Instrument to be thermally isolated from bus Heater circuits
Ground Station Passes	1-2 passes per day	1-2 passes per day	4-5 passes per day

Please note the following regarding information in the above table:

Maximum Instrument Mass: All numbers include 30% contingency.

Instrument Power: All numbers include 30% contingency.

Science Data Volume: Numbers assume 2:1 compression in the instrument, overhead and 30% margin.

Launch Vehicle: EELV, Falcon 9 or Taurus 2

Launch Date: 2014

Contamination Requirements: At the time of lift-off the external surfaces of the instrument and spacecraft shall meet MIL-STD-1246 500A level.

Pointing Control Requirements: +/- 10 arcseconds one-sigma (+/- 30 m on ground). The observatory shall be capable of performing a series of off-nadir track pointing for Targets of Opportunity observation or a series of off-nadir track pointing over the ocean to support instrument calibration (at least once per orbit). A Laser Reference System will be provided as part of the ATLAS instrument to enable processing on the ground to the required pointing knowledge.

Jitter: Jitter transmitted from the spacecraft to the instrument optical bench shall be less than 2 arc-seconds one-sigma about each axis integrated above 5Hz.

Spacecraft Motion: For nominal science operations, the instrument shall be pointed towards the local geodetic nadir with a 0.3deg forward pitch with a roll angle to point to the reference repeat ground-track. Off-pointing of +/- 5 degrees about the roll axis shall be possible. In order to accommodate instrument design requirements, the spacecraft shall maintain a fixed yaw orientation to the velocity vector. The spacecraft can have up to four fixed yaw orientations that are chosen based on the beta angle.

Clock Accuracy: The spacecraft shall provide a 1 pps clock and time at the tone message that shall be accurate to 1 microsecond to the instrument.

Communications: The spacecraft shall have S-Band RF capability to downlink real-time data at the rate of 16 kbps to ground stations, as well as S-Band capability to downlink playback data at the rates of 10 kbps and 4 Mbps for contingency purposes. The spacecraft shall also have X-Band to downlink data at a minimum of 150(TBR) Mbps for the playback of stored science and telemetry data. TDRSS SSA return at 5kbps shall also be available for contingency and launch and early orbit operations.

The spacecraft shall be commanded from ground on S-Band uplink at the rate of 2 kbps. The spacecraft also distributes the payload command through the spacecraft provided data bus. Space asset protection shall be utilized. TDRSS SSA will be used for contingency and launch and early orbit operations.

Data Handling: Housekeeping and other low rate data with the instrument shall be through a spacecraft provided Spacewire data bus to the spacecraft provided data recorder.

Eclipse periods: There will be periods where the Earth eclipses portions of the orbit. Science operations will be required during these periods.

Propulsion: The spacecraft shall have a propulsion system with the capability to provide 175 meters/second delta-V for injection error correction, orbit maintenance, collision avoidance and disposal.

Thermal: The spacecraft shall provide a clear FOV for the instrument radiators, located on both sides of the instrument.

End of life disposal: The spacecraft shall have the capability to perform a reentry maneuver to lower perigee sufficiently to cause the spacecraft to reenter into the Pacific.